SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JULY 1918.

GENERAL PHYSICS.

724. *Stabilised-Platform Weighing Scale.* **F. J. Schlink.** (Bureau of Standards, Technol. Papers, No. 106. [28 pp.], Washington, 1918.)—This paper treats of the theory and design of a new type of check-stabilised weighing scale, in which the usual pin-and-link stabilising element is replaced by a flexible elastic tape or wire, a design which practically eliminates all the friction inherent in earlier stabilising mechanisms, with the result that the total frictional resistance of the scale is sensibly independent of the position of the load on the platform. By this expedient, which ensures through suitable disposition of the platform that the stress in the stabilising element continues constantly in the sense of tension—the function of a stabilising link being then satisfactorily fulfilled by a flexible connector—the utility and application of the check-stabilised scale are greatly broadened and the accuracy of the device is much increased. The earlier types of stabilising elements are illustrated and discussed. The equilibrium conditions of the platform and stabilising element are derived, and the methods to be used in adjusting the scale are outlined. A discussion is also given of the effects of static friction on the indications of scales, and it is shown that the elimination of this friction enhances the accuracy of weighings. A. W.

725. *A Comparison of Various Manometers.* **L. Holborn.** (Ann. d. Physik, 54. 7. pp. 503–510, April 9, 1918. From the Physikal.-Techn. Reichsanstalt.)—For pressures higher than those suitable for the mercury manometer, there are several instruments on the market. These, in some instances, register pressures as high as 1000 kg./cm.^{2}. One form mentioned in detail is a differential manometer. The pressure is communicated by resin oil to the inside of a strong cylinder. Here it acts on a plunger, whose ends project from the cylinder, but whose centre, in the cylinder, is slightly tapered.

The author points out the corrections necessary for change in dimensions of the metal due to the pressures. Two manometers compared over a range 100 kg./cm.^{2} to 1000 kg./cm.^{2} differed by 0·03 % at low pressures, but by only 0·01 % above 800 kg./cm.^{2}. Another manometer, less satisfactory, showed differences from each of the above of about 0·18 %. P. E. S.

726. *Grinding Glass Tips for Drop-weight Apparatus.* **E. C. H. Davies.** (Am. Chem. Soc., J. 40. pp. 784–785, May, 1918.)—To prevent cracking of the edge of the tip during grinding, the author recommends surrounding the end of the glass capillary with Wood's metal. The glass tube made ready for the final preparation of the face of the tip is supported in a vertical position with the tip against the flat bottom of a small cardboard box. The Wood's metal is melted in a test-tube in a water bath and poured around the tip to a depth of about 10–15 mm. By raising and lowering the tube in the molten alloy or by applying a little suction to the tube the alloy is drawn a short distance into the capillary opening. Finally the tube is left with the tip against the bottom of the box until the alloy has solidified. When the paper is removed it is found that the tip is firmly embedded in the alloy. Tube and alloy are then ground with about No. 180 carborundum on a flat hard surface until the desired sharp edge is obtained. A. F.

727. *Variation of Elasticity of Tungsten with Temperature.* **H. L. Dodge.** (Phys. Rev. 11. pp. 311–315, April, 1918.)—Describes experiments on the effect of heating on Young's modulus for drawn tungsten wire. A description is given of the furnace used for the experiments and the results obtained (up to 1000° C.) are indicated in a diagram which shows a straight line relationship between Young's modulus and temperature. The values at 20° C. and 1000° C. are $35{\cdot}5 \times 10^{11}$ and $32{\cdot}3 \times 10^{11}$ dynes per cm.^2 respectively. The results obtained are compared with those previously found for mild steel, copper, and Al [see Abs. No. 1598 (1915)]. J. W. T. W.

728. *Remarks on Schrödinger's Paper on the Energy Components of the Gravitational Field.* **A. Einstein.** (Phys. Zeits. 19. pp. 115–116, March 15, 1918.) —Schrödinger has shown [see Abs. 331 (1918)] how, by a suitable choice of coordinate system, all the energy components t_σ^α of the gravitational field of a sphere may disappear. The author now examines this result and also Schrödinger's question as to whether the t_σ^α are really to be regarded as energy components. The author puts forward two supplementary questions, namely: (1) While the energy components T_σ^α of matter form a Tensor, is this not the case for the magnitudes t_σ^α which are regarded as energy components of the gravitational field. (2) The magnitudes $T_{\sigma\tau} = \sum_\alpha T_\sigma^\alpha g_{\alpha\tau}$ are symmetrical with respect to the indices σ and τ, but not the analogous expressions $t_{\sigma\tau} = \sum_\alpha t_\sigma^\alpha g_{\alpha\tau}$. The author concludes that at present a complete expression for the energy components of the gravitational field is not possible. Further communications are promised. H. H. Ho.

729. *Einstein's Gravitation Theory.* I, II, III, and IV. **H. A. Lorentz.** (K. Akad. Amsterdam, Proc. 19. pp. 1341–1369, and 20. pp. 2–34, 1917.)—The author considers that through the establishment by Einstein of equations expressing his gravitation theory, which remain unchanged by an arbitrarily chosen change in the system of coordination [Abs. 853 (1916)] and the working out by Hilbert [Gesell. Wiss. Göttingen, Nachr. Nov., 1916] of an idea suggested by Einstein, showing the use that may be made of a variation law, which may be regarded as a generalisation of Hamilton's principle, the general theory of relativity may now be regarded as having assumed a definite form. He attempts, in the present communication, to prepare the way for its future development and application to special problems: (1) by presenting the fundamental ideas in as simple a form as possible, (2) by showing how Einstein's differential equations for the gravitation field can be derived from Hamilton's principle, and, in connection therewith, dealing with the energy, stresses, momenta,

V.2
191

and energy currents in that field. By means of a four-dimensional geometric representation, it is shown that any system consisting of material points and an electromagnetic field is expressible in terms of a single quantity H occurring in the variation theorem, and which is called the *principal* function. It consists of three parts, referring respectively to the material system, the electromagnetic field and the gravitation field, the material points being assumed to have no connection other than that resulting from their gravitational attraction. Space and time are combined in the four-dimensional extension R_4, a point P in which indicates a definite place at a definite instant. The curve traced out by P when the time coordinate only varies is called, after Minkowski, a *world-line*, so that an intersection of two world-lines represents the coincidence, at a certain moment, of the two objects to which they belong. It should be noted that a propagated light-wave will have its world-line. And Einstein observes that our observations can determine only these coincidences, so that if astronomical data could be extended arbitrarily and without limit, a gravitation field, *e.g.* that of the sun, with its material points and light-waves, would be completely defined by a field-figure consisting of the world-lines in R_4, drawn so that each observed coincidence is represented by an intersection of two lines, and so that the points of intersection succeed each other in the right order. Owing to the liberty due to the intersections being the only essential parts of a field-figure, no arbitrary deformation effected without breach of continuity would in any way affect its purpose, nor would the corresponding differences to be expected in the records of independent observers—assuming all observations in each case to be correct. It should therefore be possible to express the fundamental laws of physical phenomena by geometric considerations referring to the field-figure in such manner that this mode of expression shall be the same for all possible field-figures. The introduction of coordinates is of secondary importance in a geometrical treatment of this kind, and is employed by the author only to obtain the equation representing the connection between the electric and magnetic forces, on the one hand, and the charge and convection current, on the other; and to establish the general equations, which are required for the solution of special problems. Since coordinates play no essential part in the general discussion of principles, the latter must necessarily be independent of the actual coordinates chosen, so that the general covariancy of the equations postulated by Einstein is assured beforehand. G. W. DE T.

730. *Molecular Frequency and Molecular Number. III. Inorganic Compounds. Lindemann's Formula.* **H. S. Allen.** (Phil. Mag. 35. pp. 445–460, June, 1918.)—In this communication are given values of the characteristic molecular frequency, ν, calculated by Lindemann's formula for those inorganic compounds for which data are available. The formula in question may be written $\nu = k(T_s/M\gamma^{2/3})^{1/2}$, where T_s is the absolute temperature of the melting-point, M the molecular weight, and γ the molecular volume. The coefficient k has been assumed constant, and Nernst's empirical value, $8{\cdot}08 \times 12^{12}$, has been employed.

For each compound is tabulated the value of the molecular number, N, and of the product $N\nu \times 10^{-12}$. In the majority of cases it has been found possible to express $N\nu$ either in the form $n\nu_A$ or in the form $(n+\frac{1}{2})\nu_A$, where n is an integer and ν_A is a constant frequency having a value about 21×10^{12} sec.$^{-1}$. The results given in the paper are to be considered in the light of previous work by the author [see Part I of this paper, Abs. 458

(1918)]. The author concludes as follows: "The facts recorded in the present paper are regarded as proving that the characteristic frequency calculated for a metallic compound by means of Lindemann's formula can, in general, be expressed in the form $n\nu_A$ or in the form $(n + \frac{1}{2})\nu_A$, where n is an integer and ν_A is approximately 21×10^{11} sec.$^{-1}$. The evidence for this is not considered conclusive when compounds of one single metal are examined, but the evidence in the present case is cumulative. The degree of probability of this result may be small when compounds of a single element are found to conform to the rule; but it is larger when the compounds of all the elements in a group are found to give concordant values for ν_A, and becomes very great when the number of compounds is extended to include all the groups in Mendeléeff's classification. Further, these results for compounds and those recorded previously for the elements mutually support one another, and lead to the conclusion that we have to deal with a property that is fundamental and characteristic of the solid state of matter. [It should be observed that Lindemann's formula gives only an approximate value of the characteristic frequency.] A. B. W.

731. *Rankine Trochoidal Waves.* **G. Greenhill.** (Roy. Soc., Proc. 94. 238–249, March 1, 1918.)—Rankine's theory of trochoidal waves at the surface of deep water is of use to naval architect students as a first introduction, requiring the use of elementary mathematics only, to the structure of wave motions in water, although inexact in that the assumed permanence of the waves would involve molecular rotations which could not arise in material fluids. For this purpose the author reproduces Rankine's geometrical treatment in a simplified form and shows how it may be extended in some fresh directions by the consideration that parallel walls may be introduced into the water, perpendicular to the wave crest, without disturbing the wave motion, dividing up the water into compartments, and that these may be sheared over each other in an arbitrary manner, giving an échelon wave-front, and the wave motion will continue in each compartment, and that, further, the motion may be sheared in these compartments by inclining the walls at the same angle to the vertical. The continuity of the motion in the compartments is conserved, and also the free surface condition of constant pressure. But to preserve the continuity of pressure when the walls are suppressed, some new variable field of force must generally be introduced in addition to the constant field of gravity. After an elementary geometrical discussion of particular cases, the general conditions of the problems are derived, very simply and briefly, from a generalised expression, in Lagrangian form, of a Rankine moving wave or roller, and it is shown that, by introducing the appropriate field of horizontal force, any of the solutions obtained hitherto in hydrodynamics for wave motion can be sheared continuously in a vertical plane perpendicular to the straight wave crest at a constant or variable angle, and the wave crest may be made to take any curve, and the shape of the containing vessel determined to hold the new motion, always preserving continuity in the pressure.

G. W. DE T.

732. *Visual Space.* **H. Witte.** (Phys. Zeits. 19. pp. 142–151, April 1, 1918.)—A discussion of the space outside ourselves as explored by the sense of sight. The subject is first dealt with from the geometrical point of view, but later on references are made to the psychological and physiological aspects of the matter. E. H. B.

733. *Design of Pin Joints based on Ultimate Strength.* **W. A. Scoble.** (Inst. Naval Architects, Trans. 59. pp. 92–105, 1916–17.)

734. *Theory of Wave Motion on Water.* **G. Greenhill.** (Inst. Naval Architects, Trans. 59. pp. 132–154, 1916–17.)

735. *The Solar Constant.* **E. Schwoerer.** (Archives des Sciences, 42. pp. 119–122, Aug., 1916.)—Describes the helio-thermophore, a new instrument for measuring solar radiation. The radiation is received on a small thin blackened silver plate that forms one wall of a small vessel through which water can circulate. The other sides of the vessel are insulated from external conduction and convection by a space exhausted of air. The temperature of the water is measured both on entry and on exit from the vessel. In the steady state the difference between the two temperatures becomes constant: it is proportional to the heat received and inversely proportional to the quantity of water passing through the apparatus in unit time. R. C.

736. *Terrestrial Temperature and Atmospheric Absorption.* **C. G. Abbot.** (Nat. Acad. Sci., Proc. 4. pp. 104–106, April, 1918.)—The earth's temperature depends on the balance of incoming solar and outgoing terrestrial radiation. Of these, 98 % of the incoming lies between wave-lengths 0·3 and 3·0 μ while the same proportion of the outgoing lies between 5 and 50 μ. Since about 40 % of the solar rays directed towards the earth are reflected to space it is calculated that the earth must radiate 0·29 gm. cal. per $cm.^2$ per min. from its whole surface to maintain the heat balance. If it were a perfect radiator and its radiation passed unhindered to space it would emit 0·55 gm. cal. per $cm.^2$ per min. according to Stefan's law. To explain this discrepancy, in the first place it is computed that the earth is only a 90 % perfect radiator in the required region of the spectrum, taking its power as equal to that of water. Secondly, recent experiments on atmospheric absorption of different wave-lengths have shown that only about 10–15 % of the outgoing radiation can escape through the atmosphere. Thus only 0·06 gm. cal. of earth radiation may be expected to leave the planet and the radiation from the atmosphere must supply the remaining part of the outgoing 0·29 gm. cal.; that is, about three-fourths are from the atmosphere. The chief radiating sources are (1) Clouds, (2) Water-vapour, (3) Ozone, and (4) CO_2. A consideration of the action of each of these agents suggests that an alteration in the amount of ozone in the atmosphere might profoundly affect the temperature of the earth. J. S. Di.

737. *Periodicity of Atmospheric Pressure in the Alps in Winter.* **J. Maurer.** (Archives des Sciences, 45. pp. 349–355, May, 1918.)—Mean atmospheric pressure in Switzerland for the months Nov., Dec., and Jan. combined shows a periodicity of about 8 years. Thus minima of pressure occur in the winters of 1878–9, 1885–6, 1894–5, 1903–4, 1910–11, and 1916–17, while maxima occur in the winters of 1873–4, 1881–2, 1889–90, 1897–8, 1904–5, and 1912–13. Late autumn droughts in Switzerland are associated with unusually high pressures, and as it is anticipated that the next maximum of the series will occur in the winter of 1920–1, a dry late autumn is forecasted for the year 1920. R. C.

738. *Determination of the Coefficient of Atmospheric Refraction based on the Meteorological Elements.* **V. Reina.** (Accad. Lincei, Mem. 12. No. 2. pp. 111–128, 1916.)—The original memoir must be consulted for the author's tables of comparison of calculated and observed values and the divergencies. A general formula is obtained, applicable to all Europe if the calculation of

k_1 is limited to 1 in 1000. k_1 is the value of the constant of refraction at one extreme of the luminous beam, k_2 being the value at the other extreme, and k the mean of the two. This formula makes allowance for the thermal temperature gradient at different seasons of the year and for the variation of the refraction coefficient with altitude. This formula is—

$$x_1 = 0{\cdot}000306 \frac{p_1}{(1+at_1)^2}(1 - 29{\cdot}46\tau),$$

where p_1 is the pressure and t_1 the temperature, determined at a single station, and τ the thermal gradient.

$$t_{\text{mean}} = t_1 + \tfrac{1}{2}h\tau \qquad x_2 = x_1 - \frac{x_1}{1+at_m}\left(\frac{1}{\mu K} - 2a\tau\right)h$$

$$k_1 = \tfrac{1}{3}(2x_1 + x_2) \qquad k_2 = \tfrac{1}{3}(x_1 + 2x_2) \qquad k = \tfrac{1}{2}(x_1 + x_2)$$

The following values are given for some of the constants involved: $a = 0{\cdot}003665$; $\mu = 0{\cdot}43429$; $K = 18{,}465$; $1/\mu K = 0{\cdot}000125$.

Certain constants varying with the season of the year have the values given below:—

For Jan. and Dec.	$\tau = 0{\cdot}0044$	$C = 0{\cdot}000266$
„ Feb. „ Nov.	0·0055	0·000256
„ Mar. „ Oct.	0·0068	0·000245
„ Apr. „ Sept.	0·0074	0·000240
„ May, June, July, and Aug.	0·0079	0·000234

A simplified formula is $k_1 = Cp/(1 + at_1)^2$; the appropriate value of C being taken from the above table. L. H. W.

739. *On Mild Winters.* **G. Hellmann.** (Preuss. Akad. Wiss. Berlin, Ber. 11. pp. 213–220, 1918.)—A measure of the degree of mildness of a winter is obtained by forming the sum of the *positive* daily means (in degrees Centigrade) of temperature from Dec. 1 to the last day of Feb. [Severe winters were dealt with similarly by taking the *negative* daily means, see Abs. 624 (1918).] These sums vary in Berlin, in 150 years, 1766 to 1916, between 412 and 22, the mean value being 171. Mild winters are more frequent than severe ones, and have a less decided character. In some "mild" winters occur comparatively brief periods of severe frost. The mildest winter experienced in Berlin was that of 1795–6, the mild period of which lasted from Dec. 2 to Feb. 26. No snow fell between Nov. 29 and Feb. 10, a fact which was "without parallel since 1701." Trees burst into leaf at the end of January. The longest mild winters were those of 1821–22 and 1823–24, which lasted from about Nov. 10 to the end of March in both cases.

The following general conclusions are set out:—Very mild winters usually commence in Nov. and last till March. The highest temperatures occur most frequently in Dec., and least frequently in Jan. The highest temperatures to be expected are 14° to 15° C. [In severe winters the lowest temperatures are about −28° C.]. Characteristics of very mild winters are much cloud, high humidity and rainfall, unsettled weather with much wind. Occasionally mild winters are, however, characterised by quiet, foggy weather, with much cloud and little rain. In mild winters the wind generally comes from the west. There is no regularity in the occurrence of mild winters, but they have been much more frequent in Berlin since 1862 than before. In the period 1909–10 to 1915–16, there were 7 winters, of which 5 were very mild and 1 was mild. Hence the comparatively severe winter of 1916–17 was the more remarked upon. After very mild winters there is usually a cold snap in March or April, and a normal or warm summer. R. C.

740. *Nocturnal Cooling of the Lower Layers of the Atmosphere.* **H. Perrotin.** (Comptes Rendus, 166. pp. 616–617, April 15, 1918.)—According to the equation commonly given in text-books of meteorology, the temperature θ during the night obeys the law $\theta = \theta_0 + Ae^{-\sigma/c \cdot t}$, where it is supposed that temperature changes are due to radiation only. Here θ_0 is a fixed base temperature, A a constant, σ the so-called coefficient of radiation, c the specific heat of air at constant pressure, and t represents time. On applying this equation to observations made in different parts of the globe, a constant value of σ has been found (about 0·036), which is appreciably higher than the value of the coefficient as determined in the laboratory. According to observations made at Parc St. Maur, Paris, and at three levels (heights 123, 197, and 302 m.) on the Eiffel Tower, from 1890 to 1894, the coefficient varies from 0·033 at the surface to 0·022, 0·018, and 0·016 at the higher levels. It is concluded that the cooling of the lower layers is probably not produced like that of a solid placed in a uniform-temperature enclosure. R. C.

741. *Relative Humidity.* **A. N. Shaw.** (Roy. Soc. Canada, Trans. 11. pp. 121–127, 1917.)—Arguments are brought forward to show that the commonly adopted method of expressing the water content of air by its relative humidity and temperature is unsatisfactory, and it is suggested that in all cases vapour pressure should be recorded. For physiological purposes, readings from Hill's kata-thermometer showing the rate of heat loss from a standard type of wet bulb at body temperature are recommended in place of relative humidity and temperature readings. Data are tabulated which show that the readings of the kata-thermometer satisfactorily indicate the degree of bodily comfort under different circumstances in which relative humidity and temperature are of little use as a guide. J. S. Di.

742. *Twilight Phenomena.* **P. Gruner.** (Archives des Sciences, 45. pp. 5–37, Jan., and pp. 100–116, Feb., 1918.)—This gives a detailed *résumé* of observations made in Switzerland of morning and evening sky-colours. A theory is put forward to account for the production of the effects, which depends upon diffuse reflection of light from a layer of discontinuity such as the stratosphere. It is considered that diffraction alone is insufficient to account for the phenomena, but that the diffraction effects are second in importance to those of diffuse reflection. R. C.

743. *The Relation between Simultaneous Variations of Pressure and Solar Activity.* **S. Hanzlik.** (Akad. Wiss. Wien, Ber. 126. 3. pp. 371–386, 1917.)—At times of sun-spot minima the conditions of pressure over the west coasts of the European and North American continents are such that high pressure in the Western United States corresponds with low pressure in Western Europe, and *vice versa.* At times of sun-spot maxima the reverse is the case, that is, weather conditions in the two regions are similar, fine weather being experienced simultaneously and stormy weather likewise occurring at the same time in both places. R. C.

744. *On Two Waterspouts Observed at Rabat, Morocco, on December 18, 1917.* **J. Peyriguey.** (Comptes Rendus, 166. pp. 48–49, Jan. 7, 1918.)—Descriptions are given of two waterspouts associated with heavy cumulonimbus cloud, which came up from the Atlantic with a strong SW. wind. Both were at least about 350 m. long, and extended from the cloud to 50 m.

above the surface. The first waterspout was about 4 m. in diam., the second only about 1 m. Subsequently a heavy thunderstorm was experienced.
R. C.

745. *Spectrum of the Northern Lights*. **J. Stark**. (Ann. d. Physik, 54. 8, pp. 598–614, April 26, 1918.)—It is found that in the spectrum of the northern lights, besides the positive and negative nitrogen bands and the most intense nitrogen spark lines, the most intense nitrogen arc lines occur in almost precisely the same intensity ratio as in canal rays in nitrogen. The fact that the negative N_2 band occurs in the spectrum excludes the possibility that the northern lights have their origin in an electric discharge due to large p.d.'s in the upper layers of the earth's atmosphere. Such a discharge in its passage through the atmosphere, just as with the positive column of a Geissler tube discharge, could only give rise to slow kathode rays, and hence could not cause the emission of the negative N_2 band. The intense line found in the spectrum of the northern lights whose wave-length has been elsewhere given as λ5571 is most probably identical with the intense N arc doublet λ5560–5565, the measurements of its wave-length agreeing quite as well, if not better, with this assumption, as with the value λ5571. From the occurrence of the N arc lines in the spectrum of the northern lights and from their intensities compared with the rest of the N spectrum, it is concluded that the northern lights are not due either to swift kathode rays or to α-rays, but to positive atom rays of small velocity (5000–50,000 volts). From the occasional occurrence in the spectrum of the northern lights of the hydrogen lines H_β and H_γ it appears probable that the positive rays giving rise to the northern lights are positive H rays, at any rate in part, though there may be others concerned in the phenomenon. It is possible that there may be some connection between the positive rays giving rise to the northern lights and solar protuberances and spots. A. W.

746. *Refraction on the Sun's Surface and the Height of the Calcium Flocculæ*. **P. Kempf**. (Preuss. Akad. Wiss. Berlin, Ber. 33. pp. 480–498, 1917.)—It is first pointed out that the only two investigations in which determinations of the values of refraction and depth parallax for sun-spots are based on a considerable number of stars, are those of Spoerer and Capon. But the differences between the results obtained are considerable and show the need of further accurate determinations.

Since the flocculæ are, on the commonly accepted view, supposed to be on a higher level than the photosphere, the parallax must in their case be a height parallax and not a depth parallax, and the correction for heliocentric distance ρ' for these will no longer be the *sum* as in the case of spots, but the *difference* of the refraction and the perspective parallax. The author has consequently taken his measurements of the calcium flocculæ, made in 1906, in order to see if this influence can be traced and in what degree.

From the investigation he obtains for the flocculæ the result $d\rho' = -0{\cdot}180^\circ \tan(\rho' + \rho)$, where ρ is the geometric distance from the sun's centre. For the spots the mean of Spoerer's and Capon's values gives $d\rho' = +0{\cdot}23^\circ \tan(\rho' + \rho)$. If, therefore, the refraction could be entirely neglected and the correction could be taken as solely expressing the parallactic displacement, it would follow that the level of the spots is 8·8″ below, while that of the flocculæ is 3·0″ above the level of the photosphere. If in the case of the spots the whole correction is laid to the account of refraction (which is certainly not the case), the maximum possible height of the flocculæ works out at 6·9″; that is, the altitude of the calcium flocculæ is nearly 5000 km. above the level of the spot nuclei. This latter height is, however, considered to be impossibly great in view of the fact that such a projection on the sun's limb would be quite observable; further, this value is obtained on the assumption that the spots have no depth parallax. For these reasons the conclusion must be drawn that in the corrections for heliometric distances refraction plays a minor part, as compared with the parallactic displacement. L. H. W.

747. *Secular Acceleration of the Sun from Hipparchus' Equinox Observations.* **J. K. Fotheringham.** (Roy. Astron. Soc., M.N. 78. pp. 406–423, April, 1918.)—An investigation of the solar acceleration independently of possible corrections to the lunar theory is made by the analysis of Hipparchus observations at Rhodes, with a comparison of the results from Ptolemy's work at Alexandria. The final value for the secular acceleration of the sun is $+1{\cdot}93'' \pm 0{\cdot}27''$ per century. C. P. B.

748. *Chromospheric and Coronal Spectrum,* 1911 *April* 28. **A. L. Cortie.** (Roy. Astron. Soc., M.N. 78. pp. 441–444, April, 1918.)—These results were obtained from a plate exposed through cirrus clouds during the total solar eclipse of 1911 April 28 at Vavau, Tonga Islands. In addition to the lines in the regions already investigated, numerous lines are shown in the red region $\lambda 6000$ to $\lambda 7640$ which have not previously been recorded. On account of the small dispersion the wave-length values are only given to 1 Å. A table is given showing the intensity, element of origin and references to other standards for certain lines. Many of the lines ascribed to iron are of the enhanced type now accepted as characteristic of the chromospheric spectrum. C. P. B.

749. *Planetary Motion in Space-Time of any Constant Curvature.* **L. Silberstein.** (Roy. Astron. Soc., M.N. 78. pp. 363–366, March, 1918.)—Expressions are found for the planetary motions by following up the modification of Einstein's theory proposed by de Sitter, and values given for the resulting factor of world-curvature. C. P. B.

750. *Stellar Currents.* **J. C. Sola.** (Comptes Rendus, 166. pp. 106–108, Jan. 21, 1918.)—Photographs of eleven regions of the sky have been obtained with a camera having an objective of 16 cm. diameter and 80 cm. focal length, duplicate impressions being secured with intervals from two to six years. Each region has been divided into parts for convenience in stereoscopic examination, and the tables given show what the author considers to be currents of stellar motions, designated by the position angle of shift. C. P. B.

751. *Probable Number of Nebulæ.* **E. A. Fath.** (Astron. J. 31. pp. 63–64, March 12, 1918.)—Estimates of the probable number of nebulæ based on photographs taken with the 60-in. reflector at Mt. Wilson and the 36-in. Crossley reflector at Mt. Hamilton differ considerably. The author has made a new calculation, taking account of zonal distribution from the plate centre, to allow for field distortion. His amended estimate of 262,000 possible nebulæ is still so much less than the 500,000 suggested by Perrine that Fath suggests the discrepancy may be due to lack of uniformity in the distribution of the Crossley plates. C. P. B.

752. *Absolute Parallax of Polaris.* **A. E. Glancy.** (Astron. J. 31. pp. 68–71, March 25, 1918.)—The series of declination observations of Polaris made by Bonsdorff at Odessa during 1908–1910 are investigated

for the determination of the parallax of the star. The selected value is $\Pi = +0{\cdot}086'' \pm 0{\cdot}033''$. C. P. B.

753. *Anastigmatic Eyepieces.* **A. E. Conrady.** (Roy. Astron. Soc., M.N. 78. pp. 445–447, April, 1918.)—Eyepieces in present employment suffer from non-fulfilment of the Petzval condition, having either a curved field or pronounced astigmatism. To produce an anastigmatic combination it is sufficient to employ a concave and a convex lens of approximately the same focal length. This combination is similar to that of the well-known Barlow lens. The novelty of the new eyepiece lies in the carefully computed almost achromatic negative lens, magnifying the primary image about four times, and a specially designed positive used in conjunction. By adjustment of the separation between the two elements variations of the magnifying power may be obtained. C. P. B.

754. *Graphical Methods of Testing Telescopic Objectives.* **A. O. Allen.** (Phil. Mag. 35. pp. 471–481, June, 1918.)—Practical details are given for more readily utilising available information relating to the computation for objective construction. It is quite impossible to provide complete tables for all the variations: refractive index, dispersive power, position of object, air-gaps, number of components. The calculations suggested are arranged to be available for graphical solution. C. P. B.

755. *Changes in Stellar Wave-lengths dependent on Type.* **J. Voûte.** (Astrophys. J. 47. pp. 137–139, March, 1918.)—An investigation has been made to determine to what extent stellar lines measured in spectrograms taken with the McClean telescope at the Cape show relative changes, with type, of the kind announced some time ago by Albrecht [Abs. 744 (1911)]. The spectra of four typical stars have been examined, α Canis Majoris (A), α Canis Minoris (F), α_2 Centauri (G), and α Boötis (K). A comparison spectrum of iron was used, and as far as possible the same iron and stellar lines were measured for each type. The resulting table indicates that the agreement with Albrecht's wave-lengths is in general fairly good, the main features of the variations being confirmed. C. P. B.

756. *Orbit of Spectroscopic Binary* 42 *Capricorni.* **J. Lunt.** (Astrophys. J. 47. pp. 134–136, March, 1918.)—Using the short camera with the four-prism spectrograph of the 24-in. Victoria telescope at the Cape, a series of plates were obtained during 1917 from which provisional elements of the orbit have been determined. The period is 13·25 days. The spectrum appears to agree closely with the solar spectrum in the region examined; in the Harvard system it is classed K. The star is interesting from the statement by Campbell that there were no known binaries of G, K, M types whose periods were less than 20 days. C. P. B.

757. *Dependence of Spectral Relation of Double Stars on Distance.* **C. D. Perrine.** (Nat. Acad. Sci., Proc. 4. pp. 71–74, March, 1918.)—Examination of the catalogue of spectra of 745 double stars observed at Harvard and classified by Miss Cannon showed distinctly that those stars in which the fainter component was of the earlier type were in general closer together than those in which the companion was of a later type. The stars specially selected are grouped in two tables showing the two classes. A further fact elicited is that the relation is with regard to distance coupled with low galactic latitude. There also appears to be little doubt that the fainter components are in general also of smaller mass, and that the greatest differences in spectral type are in general found among the stars whose components show the greatest differences in brightness. C. P. B.

758. *Cause of Spectral Conditions of the Stars.* **C. D. Perrine.** (Nat. Acad. Sci., Proc. 4. p. 75, March, 1918.)—The peculiar behaviour of double stars in the different portions of the galaxy [see preceding Abs.], together with the well-known preference of stars of type B for the Milky Way, suggests that spectral class depends largely on external causes. To unify the various endeavours to account for these variations, it is suggested that the spectral condition of a star depends chiefly upon its size and mass and the external conditions of density of cosmical matter and relative velocities of star and matter. Under these circumstances all the stars are probably pursuing one definite course of very slow change towards extinction, but each individual star will be pursuing a course which may have many whole or partial cycles due to varying external causes.

C. P. B.

759. *Determination of Stellar Radial Velocities with Objective Prism.* **T. S. H. Graham.** (Roy. Astron. Soc. Canada, J. 12. pp. 129-152, April, 1918.)—Calculations of radial velocities are made for stars on a plate exposed in the 16-in. telescope at Harvard in March 1915, a fiducial length-wave being impressed on the plate by an interposed screen of neodymium chloride giving a sharply defined absorption line at λ4272·8. The probable error is about 10 km./sec. Tables are given showing the results for individual stars. C. P. B.

760. *Determination of Photographic Magnitudes.* **J. Halm.** (Roy. Astron. Soc., M.N. 78. pp. 379-395, March, 1918.)—Particulars are given of the procedure followed in modern astronomical determinations of stellar magnitudes from photographic images, in relation to the general theory of photographic photometry, the determination of the time and intensity relation, and an outline of proposed methods of investigation. One of these requires the employment of a time-scale, produced by making on the same plate successive exposures of varying duration, the resulting diameters of the star-images forming the material to be measured. In the case of faint stars the time-scale may be dispensed with if standardised magnitudes of one particular region (North or South Polar sequence) are known. The methods proposed depend on the recent work of Kron, who found that for plates of the same brand developed under similar conditions, the optimal intensity may be regarded as constant. C. P. B.

761. *Magnitude Distribution of Southern Stars.* **J. Halm.** (Roy. Astron. Soc., M.N. 78. pp. 395-400, March, 1918.)—In a recent note [Abs. 1259 (1917)], Sampson concluded from a discussion of the Perth zone −32° that the Chapman and Melotte numbers did not represent the actual distribution. Halm considers that several assumptions were not admissible, and by rediscussion of the material shows that the results from the Perth zone confirm the distribution shown in Chapman and Melotte's tables down to the 18th magnitude. This is also in accordance with results derived from the discussion of stars in the Cape Photographic Durchmusterung. C. P. B.

762. *Atomic Weights of Elements in Nebulæ.* **J. W. Nicholson.** (Roy. Astron. Soc., M.N. 78. pp. 349-362, March, 1918.)—A new analysis is made of the electronic vibration system producing the unknown substance nebulium, taking account of magnetic and mechanical influences in addition to the

electrostatic forces previously considered. The resulting atomic weight found for nebulium is 1·31, coming between hydrogen and helium.
C. P. B.

763. *Number of Stars of different Magnitudes in Hyderabad Catalogue.* **R. J. Pocock.** (Roy. Astron. Soc., M.N. 78. pp. 367–372, March, 1918.)—Comets of the Hyderabad Astrographic Catalogue plates for zone −18° differs in some respects from similar comets for zone —17°. The distribution of the results is discussed in relation to the regions of obscuration investigated by Turner. The calculated galactic condensation comes rather greater than those obtained for the northern zones. C. P. B.

764. *Nova Monocerotis.* (Popular Astron. 26. p. 282, April, 1918. Nature, 101. p. 212, May 16, 1918. Abstract.)—Additional particulars are given of the nova discovered by Wolf on Feb. 4, 1918. According to information from the Lick Observatory the spectrum has reached the nebular stage. Photographs taken at Harvard also show bright lines of hydrogen, nebulium, and other unknown elements. C. P. B.

765. *Magnitude Equation and Visual Scale.* **R. H. Tucker.** (Lick Observat. Bull. 9. [No. 307] pp. 136–143, 1918.)—A long discussion is given of the determinations of the magnitude equation, and the extent of divergence existing in the unit light-ratios of the adopted visual magnitudes. The observations were made with various wire-gauze screens attached to the Lick meridian circle. C. P. B.

766. *Diurnal Variation in Atmospheric Refraction.* **R. H. Tucker.** (Lick Observat. Bull. 9. [No. 308] pp. 145–146, 1918.)—Former observations of the diurnal changes in atmospheric refraction [Abs. 904 (1917)] have been confirmed by results obtained at San Luis. The accompanying table shows systematic changes from sunset to sunrise: a sharp fall near sunset, and a sharp rise near sunrise. C. P. B.

767. *Hill's Formulæ in the Use of Hansen's Method.* **R. T. A. Innes.** (Astron. J. 31. pp. 81–82, March 30, 1918.)—The author finds several difficulties with regard to the formulæ used by Hill in reductions by Hansen's method, and asks for comment. C. P. B

768. *Motion of Faint Star in Aquarius.* **C. O. Lampland.** (Astron. J. 31. p. 96, April 2, 1918.)—Measurements on photographs taken with the 40-in. reflector at Lowell Observatory on 1911 Aug. 29 and 1917 Nov. 5 indicate that a small star of about fourteenth magnitude has a large proper motion of 0·55″ per annum in p.a. 107°. The object is 24′ from the optical axis and the image somewhat distorted, so that these values are only approximate. The position is near the planetary nebula in Aquarius N.G.C. 7009. C. P. B.

769. *Distance of the Pleiades.* **W. H. Pickering.** (Harvard Obsy. Circ. No. 206. Nature, 101. p. 252, May 30, 1918. Abstract. Roy. Astron. Soc., Canada, J. 12. pp. 225–228, May–June, 1918.)—Calculating absolute magnitudes by Russell's formula, the author has made a statistical determination of the distance of the Pleiades. The 82 stars considered range in spectrum type from B5 to A9, and the average difference between apparent and absolute magnitudes is 6·46, corresponding with a distance of 201 parsecs., and parallax = 0·0050″. C. P. B.

LIGHT.

770. *New Photographic Transit Instrument.* **F. Schlesinger.** (Am. Phil. Soc., Proc. 56. pp. 484–486, 1917.)—Experiments have been made at the Allegheny Observatory with a new form of photographic transit instrument, limited to stars near the equatorial zone, and the results are so encouraging that a more complete installation is to be constructed. Provision is made for a clock-driven camera to be moved uniformly across the meridian, electric contacts providing means of determining the times at which the camera passes certain points in its path. Two sets of photographs are taken of successive regions, so that if the constants of one group are known, those for the other may be readily calculated. The chief sources of error are (1) accidental errors in the measurement of the plates and chronographic records; (2) errors in assumed rate of clock; (3) errors due to movement of the pier in the interval between the two exposures. It is considered that the measurement errors are smaller than in visual work, and in addition the personal equation is eliminated. Preliminary experiments by exposures on the polar regions indicate that the stability of the piers in the course of a night is likely to be satisfactory. For a complete instrument a modification would be made to adapt it to all declinations. C. P. B.

771. *Petrographic Microscope.* **F. E. Wright.** (Optical Soc. of America, J. 1. pp. 15–21, Jan., 1917.)—Discusses the functions and applications of the petrographic microscope [Abs. 192 (1916)] which has now become an instrument of precision. An illustration is given of a research model microscope constructed by the Bausch and Lomb Optical Co., Rochester, N.Y. The distinctive features of this microscope are: large Ahrens polarising prism; sensitive-tint plate mounted in a sliding carriage revolvable about the axis; aplanatic condenser, N.A. = 1·4; sub-stage apertometer; rigid bar connection for simultaneous rotation of nicols; sliding adjustable mount for two objectives, so adjusted that if one objective is in focus and centred, the second on insertion is also focused and centred; combination wedge; negative and positive lenses below and above the polariser for the correction of astigmatism; swing-out lens above Bertrand lens to ensure imaging of object plane in plane of iris diaphragm in draw-tube; universal eyepiece with $\frac{1}{10}$ mm. coordinate scale, graduated quartz compensator, and biquartz wedge plate; small prism mounted in slider below eyepiece for observation of interference figures by the Lasaulx method; and sliding diaphragm with eyepiece for observation of interference figures of small mineral grains.

With this microscope it is possible to measure the optical properties of minute mineral grains and of crystal plates in thin section with a degree of accuracy hitherto attainable only on much coarser grains and plates and with a far greater expenditure of time. Refractive indices can be ascertained in grains a few microns thick, and other optical properties (birefringence, optical axial angle, etc.) on grains 0·01 mm. or more in diam. A. W.

772. *A Neutral-tint and Variable-tint Screen.* **E. Karrer.** (Frank. Inst., J. 185. pp. 539–546, April, 1918.)—Various devices have been described for controlling the intensity of a beam of radiation. In particular, most of these devices are intended to allow changes in the intensity of light by an infinite number of steps, according to some simple law which shall be the same for any and all wave-lengths; *i.e.* the screen shall be neutral. Most of such screens depend upon the absorption of light, chiefly by opaque, solid bodies. Reflection is depended upon in certain few cases. The Nicol prisms and piles of glass plates belong to the former, together with those recently considered by E. F. Kingsbury [Abs. 667 (1916)], and with photographic wedges. Scattering is depended upon in the screens which decrease the light proceeding in a certain direction by diffusing it, and is important in certain glass wedges and in photographic wedges. A photographic film, when mounted so that it may be turned, is an admirable neutral-tint screen for short limits. Solutions have never been made for neutral-tint absorbing screens, though it may be feasible to use opaque particles in a liquid, allowing them to arrange themselves under gravity or some other force and thus obtain a graduated wedge. Colloidal solutions that will jell might be used in this connection. The chief feature of disadvantage in most of the neutral-tint screens is the low max. transmission, which cannot be increased, or, if at all, only by decreasing the range of the screen. In most of the cases cited the max. transmission cannot be more than 50 %.

The neutral-tint screen described here is intended to overcome this disadvantage somewhat. However, the universality of the present screen is probably its chief point of recommendation, for it can easily be made as a variable-tint screen for use in various experiments and practices where different tints of light are compared and matched. The screen proper consists of small rectangular glass bars cut from a plate of glass whose cut edges are ground so as to be neatly laid together. Between the bars are laid narrow strips of thin opaque material, *e.g.* black paper. The glass bars are laid in a groove in a metal frame and held in place by a thin metal covering of the shape and size of the frame, and attached to it by means of screws. For rotating the screen an axis and a pointer are provided. When the screen is placed in a beam of light it will obstruct a portion of the light, depending upon the angle which it makes with the beam. The theory of this is explained in detail, and curves are given showing the degree of transmission for different angles of inclination of screen. The method of employing this apparatus as a variable-tint screen is also described, but there is need of further experiment in this direction. A. E. G.

773. *Sensitometry of Röntgenographic Materials.* **M. B. Hodgson.** (Am. J. Röntgenology, p. 610, 1917. Frank. Inst., J. 185. pp. 557–559, April, 1918. Comm. No. 63 from the Research Lab. of the Eastman Kodak Co.)—The chief obstacle to making accurate sensitometer exposures to X-rays lies in the difficulty of making consecutive exposures accurately. In white light and sensitometry, a simple rotating opaque sectored disc, with the openings proportional to the progression of exposures, may be interposed between the light-source and the plate, and a series of exposures obtained simply and accurately. With the available Röntgen equipment such procedure is impossible. The current furnished to operate the tube efficiently is pulsating, with the max. frequency usually 60 cycles per sec. Therefore, by interposing the rotating sectored disc in front of the tube operated by such pulsating current more or less synchronism occurs and grave errors follow. The most feasible method of working is to move the plate itself to intermittent motion across the path of the X-ray beam in such manner that a known progression of exposures is given, controlled to the desired accuracy. In the sensitometer adopted for the present work, the photographic plate is moved in this manner, the length of the exposure steps being controlled by an actuating electromagnetic mechanism. For the study of Röntgen emulsions it was found most convenient to use an exposure progression of consecutive powers of $\sqrt{2}$. The Röntgen-tube circuit was connected to a solenoid switch, this switch being operated at the proper time by the sensitometer mechanism. The entire operation of exposure was thus governed to within an error of 8 %. In plotting the density values of the resultant exposure strips, no absolute values are assigned to the points along the abscissæ, the curve being located merely by the known progression of exposures given assuming an arbitrary exposure unit. The type of curve is somewhat different from that usually obtained from white-light exposure. The max. density is beyond any which is optically measurable even with the most intense light-source, the curve sweeping in a close approximation to a parabola, until a density of 5·0 or more is reached. For average Röntgenographic research, however, the portion of the curve to be considered is only that limited by such a density as can be seen through the average viewing frame. This is a density of about 2·5. The method has been applied for the study of variation in the photographic effect of varying hardnesses or wave-lengths of X-rays. With the present types of X-ray emulsions the characteristic density-exposure curve has been found to increase in slope or contrast with the softness of the tube, that is, with an increase in wave-length. The rendering power of the plate from these latter curves has been found to depend both upon the plate itself and the tube hardness. The method presents an accurate means for the measurement of intensifying-screen efficiency. A. E. G.

774. *Axial Aberrations of Lenses.* **E. D. Tillyer** and **H. I. Schultz.** (Bureau of Standards, Bull. 14. pp. 341–369 [Sci. Papers No. 311], Washington, 1917.)—A description of the errors which affect the definition of a lens, viz. (i) axial chromatic aberration, (ii) oblique chromatic aberration, (iii) spherical aberration and its variation with colour, (iv) zonal variation of equivalent focal length (sine condition), (v) curvature of field, (vi) astigmatism, (vii) distortion. The relative importance of these errors in the different types of lenses is discussed. Hartmann's method of objective testing [Abs. 2861 (1904)] is extended so that one set of measurements may give all the important central errors—spherical aberration, variation of e.f.l., and axial and oblique achromatism. The accuracy of the method is discussed at length, and the results of a series of measurements made by it are given in the form of curves showing, for 17 different lenses of various types, the variation of spherical aberration and of departure from the sine condition at various distances from the centre of the lens with light of four different wave-lengths. J. W. T. W.

775. *Electric Double-refraction in Liquids.* **C. Bergholm.** (Ann. d. Physik, 54. 7. pp. 511–518, April 9, 1918.)—Treats the Kerr-effect on the electron theory, and considers the Kerr constant (B) to be a function of the following quantities: K the dielectric constant, n the original index of refraction, λ the wave-length of the incident light, d the density, M the molecular weight, T the absolute temperature, ω_1 and ω_2 the natural frequencies of the two vibration components respectively perpendicular and parallel to the axis of the unsymmetrical molecule, e the charge and m the mass of the electron.

The electric double-refraction of the molecular refraction of a layer of the substance 1 cm. in thickness inside a field of 1 electrostatic unit,

$$\frac{54\mathrm{B}\lambda n\mathrm{M}}{(\mathrm{K}+2)^2(n^2+2)^2 d},$$

is thus found to depend on the frequency of the incident light, the position of the absorption bands, the dissymmetry of the molecule, and the temperature of the substance. For closely allied substances with similar absorption spectra the above expression is almost independent of the nature of the substituted atoms and of their place in the benzine ring. [See Abs. 61 (1918).] E. H. B.

776. *Reflection and Refraction of Plane Waves.* **L. Roy.** (Comptes Rendus, 166. pp. 675–678, April 29, 1918.)—Discusses mathematically the problem of the reflection and refraction of plane waves incident on the surface of separation of two media, without introducing the assumption, based on experiment, that there is only a single reflected and a single refracted wave. A. W.

777. *Wave-length Measurements in Spectra from* 5600 *to* 9600 *Å.U.* **W. F. Meggers.** (Bureau of Standards, Bull. 14. pp. 371–395 [Sci. Papers No. 312], Washington, 1918.)—Accurate measurements of wave-lengths and determinations of the characteristics of the emission lines in the spectra of the elements are of importance in spectroscopic analysis, and for the discussion of regularities in spectra. Securing such data about the long waves has been delayed chiefly by the insensitiveness of ordinary photographic plates to the red and adjacent infra-red spectral regions. More extensive use of photographic dyes is important for these spectral investigations. Dicyanin is especially valuable and efficient as a photographic sensitiser for the long waves. The simple procedure of staining ordinary photographic plates in a mixture of dicyanin, water, alcohol, and ammonia, renders the plates quite sensitive to wave-lengths from 6000 to 9000 Å.U. Such plates were used to photograph the arc spectra of 20 of the elements, including the alkali metals, the alkaline earths, and elements commonly found in iron as impurities. The photographs were made in the first-order spectrum of a concave grating of 640 cm. radius, the grating being mounted in parallel light. Exposures were usually limited to 30 mins., and these sufficed to record waves longer than 9000 Å. U. in many of the spectra. The second-order spectrum of the iron arc was photographed on either side of the first order, and the long wave-lengths were obtained from the standards in the iron spectrum. The wave-length measurements are given on the international scale for the arc spectra of the following elements: Li, Na, K, Rb, Cs, Cu, Ca, Sr, Ba, and Mg. The wave-lengths range from 5600 to 9500 Å. U., and the probable error is less than 0·02 Å. for all lines measured more than twice. The broad and unsymmetrical character of some of the lines imposes a limit on the accuracy obtainable in the measurements. Frequency differences of doublets in the spectra of Na, K, Rb, Cs, and Cu are shown by these wave-length determinations to be constant in most cases to one part in 100,000 in the number of waves per cm. Comparison of the spectra made it possible to detect many impurities in the elements used for light sources. Still more extensive spectral investigations are required in the region of long wave-lengths to identify all the lines with certainty. A. W.

778. *Photographic Method of determining Spectral Intensities.* **G. Holst** and **L. Hamburger.** (K. Akad. Amsterdam, Proc. 20. 7. pp. 1021–1024, 1918.)—The method described is similar in principle to the well-known wedge method used for determining absorption spectra. A rotating sector with a radially increasing opening was arranged close in front of the slit. The time of illumination increases therefore along the spectral line from below upwards, and hence the most intense lines will become longest on the plate. According to Schwarzschild [Abs. 113 (1913)] the blackening of a

photographic plate is measured by the product It^p, where I is the intensity of the light, t the time, and p about 0·8. With a sector rotating at a great enough speed, it appears from the results of various workers that the value of p may approach unity. The sector employed was so designed that the length of the lines on the spectrogram was proportional to the logarithm of the intensity, the value of p being assumed to be unity. The advantages of the method are that it gives on a single photographic plate the relative intensities of many lines, and can be used just as easily in the ultra-violet region as in the visible spectrum. Quantitative measurements can be made of changes in intensity, and the measurements can be quickly made. The accuracy of the method is, however, not more than about 90 %, and greater intensity ratios than 1 : 20 cannot be determined by it. Hence the method is more particularly suited for preliminary investigations, which can subsequently be amplified by less rapid methods. A. W.

779. *Unpolarised Fluorescence and Absorption of Uranyl Double Chlorides.* **E. L. Nichols** and **H. L. Howes.** (Phys. Rev. 11. pp. 285–310, April, 1918.) —In a recent paper [Abs. 75 (1916)] an account was given of the fluorescence spectrum of ammonium uranyl chloride, and more recently [Abs. 1349 (1916)] the polarised fluorescence and absorption of four double chlorides of uranyl was described. Complete measurements of the fluorescence spectra and absorption spectra of this remarkable group of compounds have now been made and are given in the present paper, with a discussion as to their bearing on the structure of fluorescence spectra, and the relations between fluorescence and absorption. The data obtained allow the conclusions reached in the previous study of the ammonium uranyl chloride to be extended to all the double chlorides dealt with. In all four salts the fluorescence series B, C, D, E, A, have constant frequency-intervals; *i.e.* there is no indication in passing from group 1 to group 8 of a change in the interval of sufficient size to be detected. The interval is essentially the same for the potassium, ammonium, and rubidium chlorides, but appears to be somewhat smaller in the case of the cæsium chloride. This discrepancy is, however, only an apparent one. The interval is nearly the same for different series, but the evidence from these measurements, while not in itself conclusive, seems to indicate small but real variations. The strongest indication is found in the C series, which has the lowest average interval. As regards the arrangement of the bands within the groups, it was found that the group centre is in all cases almost coincident with the crest of the D band, and that the arrangement of the bands within the group is essentially the same for all. Certain minor discrepancies, such as the displacement of the A band in the spectrum of the Rb chloride, and of the B and C bands in that of the Cs chloride, can be explained by a consideration of the effect of cooling upon the spectra. Measurements made at —185° show that the four double chlorides have approximately the same average frequency-interval. The absorption spectra of the double chlorides do not exhibit the same remarkable approach to identity of structure and regularity of arrangement as is found in the fluorescence spectra. Upon analysis, however, they are all found to consist of series having intervals of approximately 70 frequency units. The average interval for all the series of a given salt is constant within the errors of observation, and is very nearly the same for all four salts. The distances between the consecutive bands are of the same order as the distances between fluorescence bands, but are less nearly equal. With increasing molecular weight there is a general shift toward the violet, and though this shift is apparently less systematic than with the fluorescence bands, in the case of such bands as show a regular shift, the total displacement is approximately the same as that observed for fluorescence: 5 frequency units from K to Cs. At —185° C. there is a general shift of the absorption bands toward the violet, more bands are present, and the bands are much narrower and sharper. These changes are readily accounted for by means of the assumption that the bands at 20° C. are concealed doublets, and that the effect of cooling is to resolve them while simultaneously reducing the strength of the stronger and increasing that of the weaker component. The average interval of each salt is the same at both temperatures. In the reversing region fluorescence and absorption are mutually destructive, but by proper screening the fluorescence may be prevented and the absorption band brought out; also by taking extra precautions to secure a dark background and to increase the excitation, the fluorescence may be seen. So far as the spectra at 20° C. are concerned, it is found that all absorption bands towards the violet from the reversing region occur in series with constant frequency-intervals, and that for every fluorescence series there is a corresponding absorption series. At —185° C. the majority of the fluorescence series reverse in the seventh group; 36 out of 38 fluorescence series are joined in the seventh group to absorption series. The exactness of reversal depends not only on the structure of the band, but on the simultaneous presence of fluorescence and absorption in this region. Other reversals and connections are present in the groups adjacent to group seven. A. W.

RADIO-ACTIVITY.

780. *Absorption of γ-Rays of Radium.* I. **K. W. F. Kohlrausch.** (Akad. Wiss. Wien, Ber. 126. 4. pp. 441–472, 1917. Comm. No. 97 from the Inst. f. Radiumforschung.)—A detailed study has been made of the absorption in Pb and Al of γ-rays from Ra and its decay products. The absorption of a parallel beam of rays has been examined after passing through "filters" of various materials and various thicknesses of the same material. The paper contains a large amount of tabulated information on this question, for particulars of which the original paper should be consulted. The author summarises his results as follows:—"It has been shown in the case of a parallel beam of γ-rays from Ra in equilibrium with its successive products, that: (1) The form of the absorption curve depends on the method of measurement. A. The absorption does not conform to a simple exponential law, if the secondary radiation originating in the absorber does not reach the ionisation vessel. B. The absorption, apart from initial softening, is exponential if the hard secondary rays are measured as a part of the incident radiation. (2) Qualitative measurements on the absorption of the hard γ-rays from RaC give the following as the most probable values of the absorption coefficients in Pb and Al:—

In lead $\mu = 0{\cdot}543$ cm.$^{-1}$
$\mu' = 1{\cdot}43$
In aluminium $\mu = 0{\cdot}125$ cm.$^{-1}$
$\mu' = 0\ 23$
and $i_\theta/i_0 = 1{\cdot}30$.

A. B. W.

SOUND.

781. *Aerial Waves Generated by Impact.* II. **S. Banerji.** (Phil. Mag. 35. pp. 97–111, Jan., 1918.)—The investigation of the origin and characteristics of the sound due to the direct impact of two similar solid spheres which was described in the first paper [see Abs. 1058 (1916)] has been extended in the present paper to the cases in which the impinging spheres are not both of the same diam. or material. The relative intensities of the sound in different directions were measured by the ballistic phonometer, and, in order to exhibit the results in an effective manner they have been plotted in polar coordinates, the point at which the spheres impinge being taken as the origin, the line of collision as the axis of x, and the intensities set off as *radii vectores* at the respective angles which the directions in which the sound is measured make with the line of collision. As might be expected, the curves thus drawn show marked asymmetry in respect of the plane perpendicular to the line of impact.

A detailed mathematical discussion of the nature of the results to be expected is possible by considering the analogous case of two rigid spheres nearly in contact which vibrate bodily along their line of centres. By choosing an appropriate wave-length for the resulting motion, intensity curves similar to those found experimentally for the case of impact are arrived at. A further confirmation is thus obtained of the hypothesis regarding the origin of the sound suggested by the work of Hertz and of Rayleigh on the theory of elastic impact.

When the impinging spheres, though not equal in size, are of the same or nearly the same density, the intensity curve drawn for the plane of observation shows the sound to be a maximum along the line of impact in either direction, and also along two directions making equal acute angles with this line. The sound is a minimum along four directions in the plane. The form of the intensity curve is practically determined by the diameters and the masses of the spheres. E. H. B.

782. *Forced Vibrations of Strings.* **A. Lampa.** (Akad. Wiss. Wien, Ber. 126. 4. pp. 389–408, 1917.)—A formal mathematical treatment of the problem starting with the equation of motion—

$$d^2y/dt^2 + 2\gamma \, . \, dy/dt - \mathrm{T}/\rho \, . \, d^2y/dx^2 = \mathrm{H} \sin pt.$$

This is solved and the initial conditions are considered. [See Abs. 1911 (1909).]

E. H. B.

783. *Composition of Vowels.* **C. Stumpf.** (Preuss. Akad. Wiss. Berlin, Ber. 17. pp. 333–358, 1918.)—This paper records investigations having for their object the analysis of the chief vowels (used in German) and their synthesis. All questions as to how they are formed by certain positions of the mouth and other cavities are left out of account. In the synthesis experiments a set of 28 pipes was used. These gave the first 22 partials of the tone *c* and the partials 24, 26, 28, 32, 40 and 48. The whole arrangement for testing the result of this scientific synthesis with the vowels as actually sung was very elaborate and involved the use of six separate rooms. The results are embodied in various tables or charts and cannot be easily abstracted. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

784. *Size and Shape of Electron.* **A. H. Compton.** (Phys. Rev. 11. p. 330, April, 1918. Abstract of paper read before the Am. Phys. Soc.)—Owing to difficulties as to the mass absorption coefficient for X-rays and γ-rays and the phenomena of scattered radiation the author advocates for the electron a *ring* of electricity of radius about $2{\cdot}5 \times 10^{-10}$ cm. E. H. B.

785. *Possible Error in Electron Charge from Droplets.* **A. Schidlof.** (Archives des Sciences, 45. pp. 157–177, March, 1918.)—A review of the researches by A. Targonski, F. Ehrenhaft, A. Karpowicz, R. A. Millikan, and others. It is pointed out that the droplets of mercury suffer changes which affect their density, also that some oil droplets suffer a change of mass. It is concluded that these effects may necessitate a slight correction in the determinations based on the method in question. E. H. B.

786. *Potential Differences induced in a Moving Wire by the Earth's Magnetic Field.* **C. Barus** and **M. Barus.** (Nat. Acad. Sci., Proc. 4. pp. 66–70, March, 1918.)—It was previously shown (Science, 45. p. 270, 1917) that the current induced in a rod about 1 m. long by the earth's vertical magnetic field, could be made surprisingly evident by the aid of an ordinary galvanometer, synchronised with the period of the inductor pendulum, of which the rod acts as the bob of a bifilar metallic suspension, including the galvanometer. If, however, the rod is insulated, the determination of the p.d. in question is quite difficult. Attempts were made to dissipate the charge from the ends by radium, electric incandescence, etc., but without effect. Other ways were tried but without ultimate success. Some interesting side-issues are described. E. H. B.

DISCHARGE AND OSCILLATIONS.

787. *Photoelectric Effects on Mercury Droplets.* **J. B. Derieux.** (Phys. Rev. 11. pp. 276–284, April, 1918.)—This work was undertaken with a Millikan condenser in order to ascertain whether in the photoelectric effect more than one electron at a time is detached from a molecule of the metal by the ultra-violet light.

The conclusion is that it is probable that in the photoelectric effect in mercury droplets two electrons are never liberated at the same time. [See Abs. 454 (1918).] E. H. B.

788. *New Method of Positive-ray Analysis.* **A. J. Dempster.** (Phys. Rev. 11. pp. 316–325, April, 1918.)—An apparatus for analysing positively or negatively charged particles is described. Examples are given of the analysis of the ions from heated salts and of the positive rays obtained by bombarding various substances with electrons. The high resolving power obtainable with the method is also illustrated. [See Abs. 251 (1914).] E. H. B.

789. *Mobilities of Ions in Air, Hydrogen, and Nitrogen.* **Kia-Lok Yen.** (Nat. Acad. Sci., Proc., 4. pp. 91–97, April, 1918.)—In this paper the question as to whether a gaseous ion is a molecule or an atom carrying an elementary charge, or whether it is a number of neutral molecules clustering about a charge, is examined experimentally by the Rutherford-Franck method [see

Camb. Phil. Soc., Proc. 9. p. 410 (1898), and Abs. 1202 (1907)] as employed by Loeb [Abs. 247 (1917)]. The experiments of Haines [Abs. 1729 (1915), 712 (1916)] which gave support to the molecular cluster hypothesis have been repeated but *not* confirmed. As a result of the experiments now described, the author comes to the conclusion that the so-called cluster hypothesis can no longer claim reason for its existence and that the arguments for the small-ion theory should be considered conclusive. A. B. W.

790. *Mobilities of Ions in Vapours.* **Kia-Lok Yen.** (Nat. Acad. Sci., Proc. 4. pp. 106–109, April, 1918.)—In a former paper [see preceding Abs.], the cluster hypothesis was condemned in favour of the small-ion hypothesis. It remained, however, for the small-ion theory to account for the difference between the positive and negative mobilities exhibited by all experimental results. This difference was simply explained by the "cluster" theory, but the explanation was not so obvious on the "small-ion" theory, supported by the author.

As a result of experiments now described, the author concludes that the apparent difficulty referred to above does not really exist at all. A. B. W.

791. *Chemistry of the Flame Arc in Relation to Luminescence.* **W. R. Mott.** (Am. Electrochem. Soc., Trans. 31. pp. 365–380; Disc., 380–390, 1917.)—The arc stream commonly consists of two differently coloured parts: the core, giving light by electroluminescence; and the outer shell, by chemi-luminescence. The nature of these components is best studied by projecting a magnified image of the arc, and the author describes a convenient apparatus for this purpose. With the flame arc 90 % of the light comes from the arc stream and 10 % from the craters; with the carbon arc the reverse is the case. The elements giving rise to coloured flames are conveniently arranged in seven groups, the more easily reduced elements being taken first. The author studies each group in succession, noting the characteristic colours produced in the flame in each case. It is suggested that the magnified arc image constitutes a convenient method of qualitative analysis. Among the results given it may be noted that there is no case of a blue arc shell; that in every case except Ba and V the arc core is blue or violet and the shell green, yellow, or red; that all the non-metallic elements give no elemental spectra, but F, Cl, O, N give some compound spectra in a carbon arc, while the intermediate elements P, As, B give no visible lines and only a few ultra-violet lines in the carbon arc. With mixtures containing the salts of K, Rb, and Cs there is a strong blast from the negative crater, but in nearly every case with a carbon arc the flow of material is from positive to negative. The *discussion* related chiefly to the boiling-points of metals. The author agreed that tungsten is the least volatile of all known elements, tantalum being second, the metals being placed in a carbon cup and forming a carbide; zirconium oxide, contrary to the accepted view, is reducible. In the flame arc, at a pressure of 22 atmos. the temperature of the sun (6000° C.) is approached. J. S. D.

792. *Resistance of the Electric Spark.* **F. Beaulard.** (Comptes Rendus, 166. pp. 678–680, April 29, 1918.)—The author has, in earlier papers [Abs. 2370 (1901) and 708 (1902)], described a method of calculating the damping of an oscillatory electric spark produced by the discharge of a condenser of capacity C through a circuit of resistance R and self-induction L, which includes a gap of several mm. across which the spark passes. The same method allows the resistance of the spark to be deduced, by means of known

relations, from the value of the damping; the resistance thus determined is that of the solid conductor which, if substituted for the spark, would produce the same damping. Experiments on sparks of lengths from 1 to 10 mm. showed that the resistance of the spark decreased from 0·0298 ohm for 1 mm. length to 0·007 ohm for 10 mm. length. It should be noted, however, that there is a different potential for each spark-length and consequently a different energy of charge; hence the results should be reduced to the same potential of charge. When this is done the resistance increases with the spark-length. The quantity R/l, where l is the spark-length, is not, however, constant. It increases at first, remains nearly constant for lengths of from 3 to 5 mm., and then diminishes. The results show that the spark resistance is a very complex phenomenon, and accordingly no very definite measurements can be made. A. W.

793. *Light Emission of Gases and Gas Mixtures by Electric Discharges.* **L. Hamburger.** (K. Akad. Amsterdam, Proc. 20. 7. pp. 1043–1048, 1918.)—This paper gives a short account of the most important results obtained in an investigation on the influence of different factors upon the emission of light by gases and gas mixtures due to electric discharges. The method used was that of Holst and Hamburger [see Abs. 778 (1918)]. The discharge apparatus was similar in construction to the continuous discharge apparatus of Konen and Jungjohann [Abs. 698 (1910)], in which streaming gases were used. Investigations were made on N, H, Ar, Ne, and He. With N it was found that the emissive power is proportional to the supplied energy. For constant current-density the intensity of the light decreases with a decrease of the pressure over the range investigated, and at the same time the maximum of the emitted energy is shifted towards the shorter wave-lengths. At a change of the pressure of the gas the bands belonging to the negative pole show a characteristic difference in behaviour from the bands of the second positive nitrogen group which surround them. The potential gradient in the positive column decreases with decrease of pressure and also with increase of the current intensity. Near the kathode the passage of a current gives rise to a decrease in pressure, which for high values of the current density is relatively great, and the value of this pressure effect is approximately proportional to the current intensity. There is a corresponding pressure-increase at the anode. The pressure effect is found to be smaller in gases with lower molecular weight. Observations on H, Ne, and He are in general agreement with those on N. In all cases the intensity of the spectral lines or bands is proportional to the supplied energy, and with decrease of pressure the energy maximum is shifted towards the ultra-violet. With Ar the red and blue spectra exhibit totally different behaviour with respect to the supplied energy. With increasing current strength the intensity of the red Ar spectrum at first rises rapidly and afterwards more slowly. With the blue Ar spectrum the reverse is the case. In the case of mixtures which do not react it was always found that a decrease in pressure causes a shift of the max. light emission towards the ultra-violet. With the reacting mixtures N–O, N–H, and N–CO, in each case the reaction was accompanied by the occurrence of new bands. Investigation of the system N_2–H_2 supported the view that electric ammonia-synthesis is preceded by a disintegration of the reacting molecules into atoms. Further details will be given later. A. W.

794. *Sparking Potential of Argon-Nitrogen Mixtures.* **G. Holst** and **A. N. Koopmans.** (K. Akad. Amsterdam, Proc. 20. 7. pp. 1025–1035, 1918.)—In

the so-called half-watt lamps with a relatively thick wire, in which the loss of heat to the gas is comparatively small in relation to the radiated heat, nitrogen is commonly used, whereas argon is used in lamps with thin wires, as its conductivity for heat is much smaller. The substitution of argon for nitrogen produced a new difficulty, namely, the occurrence of electric discharges through the gas. By the addition of small quantities of nitrogen it has been found possible to raise the sparking potential by a considerable amount. The experiments here described were undertaken to investigate further this effect. The method used was based on the drop of potential at the terminals of a condenser connected in parallel with the discharge tube at the moment of passage of a spark. The apparatus and method were first employed to obtain sparking potentials in air, and results were obtained in agreement with those of other observers. The results for nitrogen lie between those of Orgler and the values found by Bouty for the "critical field," a quantity which is practically identical with the sparking potential. A series of readings for various percentage mixtures of argon and nitrogen was made, and the results obtained are tabulated and graphed. If the pressure is constant for a series of mixtures containing more or less argon the sparking potential shows a continuous fall with decreasing percentage of nitrogen, the fall being very rapid as pure argon is approached. With the highest value of *ps* used (*p* being the gas pressure and *s* the distance apart of the electrodes) the sparking potential for a mixture containing 10 % of nitrogen was found to be almost exactly four times that for pure argon, and this ratio was nearly the same for the other values of the quantity *ps* which were employed. In all cases the sparking potential of pure nitrogen was 9 or 10 times that of pure argon. The extremely low sparking potential for argon can be explained by Townsend's theory. A. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

795. *Wave Velocity and Capacity of Horizontal Helices.* **A. Press.** (Electrician, 81. pp. 106–107, June 7, 1918.)—Cohen has shown how the formula $V^2 = 1/LC$ can be used to calculate the capacity of wires arranged horizontally, provided the inductance is known [Abs. 448 (1918)]. The present paper deals with the modifications necessary if the formula is to be applied to *helices* whose axes are horizontal. It is shown that a helix is equivalent to a wire of the same length and radius as the helix, situated at the same height above the ground in a medium of permeability μ, where μ = (Inductance of helix)/(Inductance of equivalent wire). The result of a calculation of the wave velocity of a long helix is in approximate agreement with experiments made by Fleming ("Electric Wave Telegraphy," p. 350, 3rd edition 1916). The calculated value of the capacity of the helix is 31·3 micro-mfd., whereas the value found by experiment is 45 micro-mfd. In the calculations, however, no allowance has been made for the variation in inductance and capacity per unit length or for end effects. In a more precise theory these details would be considered. **P. R. Coursey.** (*Ibid.* 81. p. 212, July 5, 1918.)—Using a more accurate expression for the inductance of a straight wire, Coursey shows that the calculated values of wave velocity and capacity of a horizontal helix agree more closely with experimental results than the values obtained by Press. N. W. M.

796. *Rheostat Design.* **H. L. Dodge.** (Iowa Acad. Sci., Proc., 24. pp. 183–187, 1917. Abstract.)—If a rheostat is connected in series with the load, small currents cannot be obtained with a given voltage supply. If the load is shunted across a portion of the rheostat on the potentiometer principle, only a fraction of the full current capacity is available. To secure the advantages of both methods of connection there must be a complete rewiring of the circuit, involving loss of time and possible injury to the rheostat and other apparatus when used by students. These difficulties have been eliminated in a new design in which the line and load terminals are separate, and the change from series to shunt connection is made by closing a simple switch. With the switch open, values of current up to the full capacity of the rheostat may be secured; with it closed, small values of current and voltage, down to zero, are obtainable. A new feature of the design is that by proper choice of resistance and winding the voltage and current ranges in the two arrangements may be made to overlap for any load, no matter what its resistance. Thus, with a 110-volt supply and a load of 15 ohms, a rheostat of 80 ohms and a current capacity of 5 amps., the series arrangement permits currents from 2·5 to 5 amps. to be obtained, while the shunt arrangement gives currents from 0 to 2·5 amps. For a given voltage and size of tube on which the wire is wound (watt-capacity) there is one winding, and only one, which will give the max. current capacity and yet provide, for any load, overlapping of the series and shunt ranges. With the ordinary rheostat there is no means of knowing with what voltage it can be used, nor is there any indication as to whether it is capable of giving overlapping ranges. With the new design, voltage and current capacity are made the determining characteristics, and the resistance is incidental. If the windings are properly worked out the resulting current capacity is the greatest which can be secured with the given voltage, and within these max. limits all values of current and voltage down to zero may be secured, no matter what the load. Thus the new type is not only easy to connect and to operate, but it possesses the highest possible efficiency. A. W.

797. *Breakdown Effect in Boron Conductors.* **F. W. Lyle.** (Phys. Rev. 11. pp. 258–260, April, 1918.)—When across a layer of any of the ordinary insulating materials a voltage greater than a certain critical value is impressed, the familiar phenomenon of "breakdown" occurs; *i.e.* its insulating property is lost, usually with the accompaniment of destructive physical and chemical changes. There are, however, materials which exhibit all the electrical characteristics of the action without any such destructive accompaniment. Such materials have, like the common insulating materials, a negative temperature coefficient of resistance. In these substances, such as boron, the breakdown action can readily be shown to be due, in a general way, to the cumulative effect of internal heating on the electrical resistance of the substance. By reason of its negative temperature coefficient the resistance continually decreases as the temperature of the slab rises, and when this has proceeded far enough the heating becomes very rapid and the current rises quickly to the limiting value imposed by external resistance. It will be noticed that breakdown does not occur instantaneously, but that time is required for it to set in, just as in the case of ordinary insulating materials. Experiments showed that under certain voltage stresses boron exhibits many of the characteristic phenomena exhibited by insulators at breakdown. The existence of a breakdown action, the time needed to effect it, the existence of a critical voltage of "breakdown at infinite time," and the influence thereon of room temperature and thickness of test specimen, are all paralleled by similar characteristics of ordinary insulators. The results obtained point strongly to the possibility that thermal effects are controlling factors in the breakdown of ordinary insulators, just as in the case of boron. A. W.

ALTERNATING CURRENTS AND MAGNETISM.

798. *Contribution to the Quantum Theory of Paramagnetism.* **F. Reiche.** (Ann. d. Physik, 54. 6. pp. 401–436, March 21, 1918.)—A mathematical paper. The kinetic theory of paramagnetism of Langevin led to Curie's law that the molecular susceptibility is inversely proportional to the absolute temperature. Onnes and Oosterhuis, however, showed that this law did not hold at very low temperatures. The problem of setting up a theory of paramagnetism on the basis of the quantum hypothesis has been taken up by Oosterhuis and Keesom, Gans, and Weyssenhoff. The theory of the last-mentioned author employs fixed axes of rotation; in the present paper an extension is made by the employment of free axes of rotation, *i.e.* two degrees of freedom. Starting from the Jacobi-Hamilton equation, the quantum conditions are introduced and an expression is obtained for the molecular susceptibility; this is considered in the light of particular cases; further, the calculated values of the susceptibility for various substances are compared with the experimental results of Onnes and Oosterhuis, good agreement being obtained. [See Abs. 698 (1913) and 347, 348 (1916).] G. E. A.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

799. *Radioscopic Localiser.* **C. Ropiquet.** (Archives d'Él. Médicale, 26. pp. 19–25, Jan., 1918.)—This outfit recommends itself by its simplicity and portability. By its aid a precise localisation of projectiles in the body or limbs can be performed without any special installation. Two views are required: one vertical or nearly so, the other oblique. When obtainable a diaphragm or cross-threads are employed, but these accessories are not indispensable. Any table will do, providing that it is permeable to X-rays, and it need not be horizontal. A litter placed upon two trestles will do equally well. The distance of the bulb from the screen or table is immaterial, as is also the amount the bulb is displaced for the second view. The two views may even be made at different levels. When packed the apparatus measures only 65 × 30 × 16 cm. and weighs about 13 kg. A. E. G.

800. *Elimination of Secondary Radiation in Radiography—The Antidiffuser.* **Tauleigne** and **G. Mazo.** (Archives d'Él. Médicale, 26. pp. 160–163, April, 1918.)—Distinct radiographs of the thicker parts of the body are very difficult to obtain owing to the amount of secondary radiation which occurs. The apparatus here described has been designed with the idea of cutting out the effects of this secondary radiation and so enabling radiographs of the body to be obtained comparable in definition with those of the hand, etc. It consists essentially of a chassis moved by clockwork upon rails, under which the photographic plate is introduced, the subject to be radiographed being placed upon a board, covering the chassis. The plate and subject remain at rest, the chassis only being movable. The action of the secondary radiation is annulled by thin sheets of lead suitably placed in the chassis. The method of using the antidiffuser is described, and diagrams illustrating its construction are given. It is claimed that radiographs taken with the aid of this appliance, using screens and hard radiations, and without undue narrowing of the image, give entire satisfaction to photographer, radiographer, and surgeon alike. A. E. G.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

801. *Periodic System of the Elements.* **C. P. Steinmetz.** (Am. Chem. Soc. J. 40. pp. 733–739, May, 1918.)—The author examines various geometrical methods of representing the periodic character of the elements, and arrives at the following conclusion:—"The periodic system of elements, with its single, double, and quadruple periodicities, cannot be graphically illustrated on a plane, cylinder, etc., but it can be correctly represented on a Riemann surface with singular points at —40 and —130." Various diagrams are given in illustration of the various geometrical representations mentioned in the paper. A. B. W.

802. *Periodic System of the Elements.* **P. V. Wells.** (Washington Acad. Sci., J. 8. pp. 232–234, April 19, 1918.)—The electron theory of atomic structure gives to the periodic system a new significance. This is shown clearly in the "spiral" periodic table of Stoney [Roy. Soc., Proc. 85. p. 471 (1911)] and others as revised by Harkins and Hall [Abs. 471 (1916)]. The spiral form has the advantage of being in a plane instead of in space, and thus of naturally representing two coordinates—atomic number and atomic weight. The author now gives a modification of the spiral of Harkins and Hall for which he claims several important advantages. The distance from the centre of the spiral represents atomic weight, the elements occurring in angular order of atomic number, increasing with clockwise rotation. Each group is thus arranged radially, the sub-groups being slightly displaced. A. B. W.

803. *Recent Studies on Active Nitrogen.* **R. J. Strutt.** (Chem. Soc. J., Trans. 113. pp. 200–209, April, 1918. Lecture.)—A stream of rarefied nitrogen was drawn through a horizontal discharge tube, the circuit comprising Leyden jars, into a wider, long tube; into this second tube other gases were admitted to mix with the activated nitrogen [see Abs. 1745 (1913)] without being themselves submitted to the electric discharge. The yellow luminescence of the active nitrogen (which is not a temperature radiation) almost ceased with the discharge, persisting at the best for a few minutes. When acetylene was admitted, hydrocyanic acid was formed (Prussian-blue test); the colour changed into lilac, and the spectrum showed the cyanogen bands. With mercury vapour the active nitrogen formed a nitride (ammonia test). Liquid mercury shaken in the yellow gas was fouled, nitride being formed, and the yellow colour vanished; the mercury lines were not observed in this last case. The spectrum of the active nitrogen is deficient in some nitrogen lines; when oxygen or some other substances (CO, CO_2; also methane, ethane, etc.) are admitted, the lilac light is marked by two bands in the ultra-violet, one of which is not otherwise known, whilst the other band is found in the Bunsen flame when nitrogen oxides are introduced; yet the active nitrogen does not appear to contain any oxide. According to Koenig and Elöd the discharge produces a modification of oxygen (not ozone) which unites with active nitrogen. The author had formerly considered the absence of oxygen essential for the formation of active nitrogen, whilst Tiede and Domcke had declared the presence of oxygen as indispensable for the activation. The author has since found that a trace of some other substance is favourable, but that almost any substance will do: it need not be oxygen or an oxygen compound. In these experiments he purifies the nitrogen by heating it over metallic sodium and admits the other gases through capillary tubes; *e.g.*, 1/30 000

part of methane suffices. As regards the electric condition, the condensed discharge is more effective than the discharge without jars, and when the gas stream is made to traverse the column between the positive and negative electrodes, it is found that the blue negative glow near the kathode is the most effective, the dark Faraday space the least effective, and the positive column fairly effective for the activation. H. B.

804. *Typical Cases of the Deterioration of Muntz Metal by Selective Corrosion.* **H. S. Rawdon.** (Bureau of Standards, Technol. Papers, No. 103. [28 pp.], Washington, 1917.)—The deterioration of Muntz metal by selective corrosion is illustrated by four types, including tubing, sheets, and forgings. The metal becomes red in colour, very weak and brittle by this type of corrosion, which takes place when the piece is exposed to some electrolyte. The metal has a duplex structure, one of the constituents, β, being very much higher in zinc than the other, α. In all cases, the selective corrosion consists of a preferential attack of the zinc-rich constituent and the formation of a porous "copper" mass which fills the network of holes previously occupied by the β. This attack may or may not be followed by that of the second constituent. This attack of the α constituent may follow almost immediately that of the β or it may be indefinitely delayed.

A state of dezincification may result in α brass under certain conditions, although the method of attack as revealed by the microstructure is different. The line of demarcation between attacked and unattacked portions is very sharply defined, the change being abrupt and complete even within the individual β crystals. One of the most important conditions favourable to this type of corrosion which occurs commonly while the metal is immersed in sea-water, is the accelerating effect of the closely adhering deposits of basic zinc chloride resulting from the attack of the metal. Other influences which may accelerate the rate of attack are: contact with substances more electro-negative than either the α or β constituents, an increase of temperature, and the effect of stresses to which the material may be subjected while in service. Thorough annealing of Muntz metal does not entirely prevent the selective corrosion of the β constituent. C. O. B.

805. *Researches on High-speed Steel carried out at the Harvard Laboratory.* **Yatsevitch.** (Rev. de Mét. 15. pp. 65–115, Jan.–Feb., 1918.)—The author discusses the theories which have been put forward to account for the special properties of high-speed steel, and points out that a satisfactory theory has not only to account for the necessity for heating to a very high temperature in order to effect hardening, but also for the fact that the peculiar type of hardness persists even at a red heat. None of the theories advanced up to the present are capable of giving a clear explanation of all the observed phenomena. Accordingly the author has carried out an extensive investigation on a steel containing 18·2 % W, 3·00 % Cr, 0·62 % C, 0·95 % V, 0·27 % Si, and 0·38 % Mn. The experimental work consisted in determining heating and cooling curves at various rates of heating and cooling, after which microscopic and hardness tests were made on thermally treated specimens. At slow rates of heating and cooling (82 and 129 mins. respectively between the temperatures 200° and 1000° C.), heating curves showed a gradual exothermic change having a maximum between 400° and 500°, a critical point at 773°, and an upper point starting at 818° and attaining a maximum at 856° C. Cooling curves showed only one critical point at 750° unless the max. temperature of heating had not attained some critical temperature between

980° and 1000° C. Such treatment resulted in a lowering of the critical point to 710° and the introduction of a new point at temperatures between 500° and 800° C. This lower point increases in intensity with the initial temperature of heating. Moderate rates of heating gave a critical point of 750° and a point commencing at 808° and attaining a maximum at 882° C. On cooling the lower point is found at a much lower initial heating temperature. Starting from 850° C. the upper point is found at 670° and the lower point at 245°, while on starting from 1000° C. the upper point has practically disappeared and a very large critical point occurs at 370° C. Very rapid cooling produces very similar results except that the lowering of the upper point on cooling is very much more pronounced. The range of fusion was found to lie between 1310° and 1465° and the solidification range between 1447° and 1284° C. Cooling curves from the liquid also showed an arrest at 1015° which appeared to correspond with the appearance of a eutectoid in the microstructure. In the microscopic examination use has been made of a solution containing caustic soda and hydrogen peroxide for etching purposes. Carbides of tungsten, etc., are darkened while cementite remains unaffected by this reagent which shows high-speed steel to consist of dark particles of carbides in a clear matrix. Above 800° C. the particles tend to disappear, the solution progressing as the temperature rises; but is not quite complete even after 25 minutes' heating at 1240° C. Quenching from above 1100° C. produces a polyhedral structure which increases in regularity with increase of temperature. With regard to hardness a max. value is obtained on quenching from 1150° C. At the upper critical point a rapid increase of hardness occurs.

F. C. A. H. L.

806. *Experiments on the Manifestation of Osmotic Pressure with Membranes of Chemically Inert Materials.* **S. L. Bigelow** and **C. S. Robinson.** (J. Phys. Chem. 22. pp. 99–127, Feb., 1918.)—The authors describe experiments of a preliminary character, using septa of silica, graphite and amorphous carbon, metallic copper, silver, and gold. A. F.

807. *Experiments on the Manifestation of Osmotic Pressure with Membranes of Chemically Inert Materials.* **S. L. Bigelow** and **C. S. Robinson.** (J. Phys. Chem. 22. pp. 153–183, March, 1918.)—The authors communicate the results of experiments carried out with septa of silica, amorphous carbon, graphite, copper, silver, and gold and solutions of cane-sugar. The septa were prepared by compressing powders of the various materials, and by clogging the pores. It was found that when the pore diameters were below a certain value, differing in the case of the different septa, osmotic effects were obtained, and the magnitude of the osmotic effects increases with a decrease in the diameters of the pores of the septa. In this way it has been demonstrated that osmotic pressure can be produced through the agency of capillary forces alone without the aid of solution processes or chemical reactions. The authors discuss the different views which have been expressed as to the mechanism of osmosis, and point out that it is probably a mistake to think that the mechanism is the same in all cases. A. F.

808. *The Kinetic Theory of Osmotic Pressure and the Raoult Law.* II. **G. Jäger.** (Ann. d. Physik, 54. 6. pp. 463–480, March, 21, 1918.)—In his work on the osmotic-kinetic theory of dilute solutions, K. Jellinck has put forward various objections to the present author's interpretation of osmotic pressure and related phenomena. A detailed reply has had to be postponed until now owing to paper shortage in Germany. In Section 1, the author examines mathematically the general mechanism of osmotic pressure; he concludes that for the calculation of the osmotic pressure the existence of the solvent can be ignored, while the dissolved substance may be regarded as existing in gaseous condition in the given volume. In Section 2, the internal pressure of a dilute solution is investigated and an additional proof is given of the theorem that a dilute solution must possess the same internal pressure as the pure solvent. In Section 3, the vapour tensions of dilute solutions are examined. The paper is mathematical throughout. H. H. Ho.

809. *Contact Catalysis.* IV. **W. D. Bancroft.** (J. Phys. Chem. 22. pp. 22–48, Jan., 1918.) [For Parts I–III see Abs. 127, 590, and 591 (1918).]—If one of the reaction products is absorbed sufficiently strongly by the catalytic agent, it will poison that catalytic agent, and if the catalytic agent is poisoned sufficiently, the reaction will come practically to a halt. When a reaction is thus brought to a standstill, the apparent equilibrium will depend on the relative amount of the catalytic agent. A system in which there was a constant amount of catalyst would present the phenomenon of Duhem's false equilibria if the catalyst were poisoned sufficiently by one of the reaction products. Melted Se acts as a catalyst for the reaction between hydrogen and Se, and it is apparently poisoned by hydrogen selenide. Melted sulphur probably acts as a catalytic agent for the reaction between hydrogen and sulphur, although this is disputed by Bodenstein, and it is apparently poisoned by hydrogen sulphide. It is possible, although not proved, that the discrepancy between Pélabon and Bodenstein's results with hydrogen sulphide and hydrogen selenide is due to Bodenstein having used relatively more S and Se than Pélabon did, just as was claimed by Duhem. With varying amounts of catalyst to be poisoned, we may get all possible false equilibria between the limit of no reaction and the limit of reversible equilibrium. The theory of false equilibrium as outlined in this paper is in harmony with all our thermodynamical relations. A. F.

810. *On the Fundamental Values of the Quantities* b *and* √a *for different Elements, in Connection with the Periodic System.* V. *The Elements of the Carbon and Titanium Groups.* VI. *The Alkali Metals.* **J. J. van Laar.** (K. Akad. Amsterdam, Proc. 20. 3. pp. 492–504, and pp. 505–519, 1918.)—V. In this paper the author communicates the calculated values of b and $\sqrt{a}$ for the elements of the carbon group and for titanium, zirconium, cerium and thorium. They are as follows:—

	$\sqrt{a_k} \times 10^2$	$b_k \times 19^5$		$\sqrt{a_k} \times 10^2$	$b_k \times 10^5$
C	32	100	Ti	35	182·5
Si	34	155	Zr	37	237·5
Ge	36	210	Ce	39	292·5
Sn	38	265	Th	41	402·5
Pb	40	375			

It follows that the values of the *molecular attractions* $\sqrt{a_k} \times 10^2$ must be taken very high, ranging from 32 for carbon to 40 for lead. These values are very much higher than the residual attractions for the compounds of these elements, which range from 3 to 11. This means that we have to do here with free atoms which exhibit a so much greater attraction than the bound atoms in the molecule. This fact is confirmed also by Ti, Zn, Ce, Th, as well as by antimony ($\sqrt{a_k} = 32{\cdot}5 \times 10^{-2}$) and bismuth ($\sqrt{a_k} = 36 \times 10^{-2}$). So far as the values of b_k are concerned, they appear to be the same as those which are also calculated from the compounds—which might have been expected beforehand.

VI. The values of $\sqrt{a_A}$ and b_A calculated by the author are as follows :—

	$\sqrt{a_A} \times 10^7$	$b_A \times 10^5$
Lithium	22·6	145
Sodium	26·9	266
Potassium	33·2	481
Rubidium	35·1	579
Cæsium	37·7	707

From the values of $\sqrt{a_A}$ it appears that all these metals occur atomically.

A. F.

811. *Free Energy of Hydrochloric Acid in Aqueous Solution.* II. **A. A. Noyes** and **J. H. Ellis.** (Am. Chem. Soc., J. 39. pp. 2532–2544, Dec., 1917.) —In a previous article [see Abs. 1091 (1916)] were presented the results of measurements of the e.m.f. of the cells H_2 (1 atmo.), HCl (4·5 to 0·01 M), Hg_2Cl_2 (solid) + Hg ; and from these were computed various energy quantities and activity values for the ions of hydrochloric acid. It was found impossible by the use of this cell to secure reliable results at acid concentrations below 0·03 M, and it was necessary to employ the data of Jahn to extend the table of activity values to still lower concentrations. The desirability of additional e.m.f. data to confirm and supplement the work of Jahn at low concentrations led to the undertaking of this work, in which the calomel electrode previously used was replaced by a silver-chloride electrode in the hope that it would give more accurate measurements at very low acid concentrations. The silver-chloride electrodes were found to give more reliable results with dilute acid than did the calomel electrodes, but they failed when the acid concentration reached 0·0003 M, and at 0·001 M they were unreliable. The difficulties of e.m.f. measurements at low acid concentrations are such that an excess or deficiency in chloride ion of only 0·0003 mgm., even if uniformly distributed throughout the contents of the 20 cm.^{3} electrode vessels used, produces an error of 0·0001 volt at an acid concentration of 0·001 M—an effect which might well arise from adsorption phenomena. A description of the apparatus used is given and the effect of light on the silver-chloride electrodes investigated ; this effect is found to be small, the silver-chloride electrode having a definite potential whether in light or darkness. Tables of experimental results are given, and decreases in free energy and in heat content are calculated from the e.m.f.'s Then follows a discussion of the free energy values together with a computation of the specific electrode potentials. The relative activities of the ions of the acid at various concentrations are finally dealt with. The results show that even at 0·0034 M, hydrochloric acid is still far from being a completely ionised perfect solute. From the data in this and the previous articles, the difference between the electrode potentials of the half cells Ag + AgCl, Cl^- (1M) and Hg + Hg_2Cl_2, Cl^- (1M) have been computed, and the separate values of these specific potentials referred to the molal hydrogen electrode found to be :—

For Ag + AgCl, Cl^- :—0·2299 at 15° ; — 0·2238 at 25° ; — 0·2172 at 35°.
For Hg + Hg_2Cl_2, Cl^- : — 0·2729 at 15° ; — 0·2700 at 25° ; — 0·2667 at 35°.

The electrode potential of the normal calomel electrode, Hg + Hg_2Cl_2, KCl(1N), at 25° was found to be — 0·2824, in fair agreement with the value — 0·2828 recently published by Lewis, Brighton, and Sebastian. Upon the assumption that at the lowest concentration (0·0084M) at which the measured e.m.f.'s are exact the ion activity is equal to the ion concentration, a revised series of activity coefficients for hydrochloric acid from 0·0084 to 4·5M has been computed, and these show a divergence of about 10 % from the conductance ratio at 0·1M. A minimum value is attained at about 0·5M and increases very rapidly at concentrations above 1M. H. H. Ho.

812. *The Colour of Inorganic Compounds.* **F. R. v. Bichowsky.** (Am. Chem. Soc., J. 40. pp. 500–508, March, 1918.)—Every valence state of an element can be associated by means of purely experimental evidence with a definite "atom colour"; and there is a marked relation between atom colour thus determined and valence and valence variability. The atom colour of every element in its normal valence state, that is in the valence state which corresponds to its place in the periodic system, is zero. The atom colour of an element, in valence states where the valence is decreased or increased by an odd number from the normal valence, lies farther in the blue than the atom colour of the same element in any other valence state. The atom colour of an element in a state whose valence is removed by an even number from normal, will be zero if compounds of the element do not exist, in which the valence of the element is removed by an odd number from normal; otherwise the atom colour will lie farther in the yellow than the atom colour of the same element in a state of valence removed by an odd number from the normal. Manganese *eka* and *diva* manganese belong in the eighth group with iron and the rare earths, and not in the seventh group with chlorine. Mercurous, gallous, and indous salts are double complexes. So is the ferric ion. Compounds between non-variant-valence elements will be colourless; and compounds between a non-variant-valence element and a variant-valence element will have the same colour as the "atom" of variant-valence element. Compounds between other elements will have colours more to the blue than the sum of their atom colours. All these regularities can be deduced from a variation of Lewis's theory of atom structure, and the almost perfect accord between the deduction and the facts indicates very strongly that Lewis's fundamental hypotheses are correct. A. F.

813. *Thermodynamics of Adsorption.* **A. M. Williams.** (Roy. Soc. Edinburgh, Proc. 38. pp. 23–39, 1917–1918.)—The present paper is the result of some previous calorific work on adsorption which led the author to a closer consideration of the thermodynamical aspects of the problem [see Abs. 825 (1917)]. The adsorption of a gas has been investigated thermodynamically, with special reference to the heat effects accompanying adsorption. Expressions are developed for three isothermal heats of adsorption of a gas, and for the heat of immersion of a powder in a liquid. The effect of the variation of the surface of an adsorbent when adsorbing is examined, and it is shown from Titoff's observations (assuming the adsorption to be reversible) that the divergence between calculated and observed values of the heat of adsorption is to be explained on the assumption of a change of surface area. The fractional change of surface per cm.^3 adsorbed is examined mathematically, and an expression for calculation purposes obtained. In like manner the surface energy per gm. of adsorbent *in vacuo* is investigated. Data for ammonia, carbon dioxide, and nitrogen, are given in the paper.
H. H. Ho.

814. *Passivity of Chromium.* I. **A. H. W. Aten.** (K. Akad. Amsterdam, Proc. 20. 6. pp. 812–823, 1918.)—A summary of the various theories of pas-

sivity is first given [compare Abs. 1727 (1908)], after which potential measurements with three kinds of chromium electrodes are described. The three kinds of chromium were prepared (1) by Goldschmidt's thermit method, (2) by electro-deposition on copper from a solution containing 12 % of chromium sulphate and 13 % of chromic acid, (3) by electro-deposition on copper from a solution of chromium chloride containing 100 gm. of Cr per litre. The potentials were measured against a solution of chromous sulphate containing about 0·3 mol. $CrSO_4$ per litre, and became constant after several days. The mean of 136 measurements gave $-0{\cdot}55$ volt (referred to the normal calomel electrode) as the potential of electrolytic Cr in a solution of chromous sulphate. This is called the *end potential* by the author, and considerations are advanced in support of it being a hydrogen and not a chromium potential. If the surface of the Cr had hydrogen dissolved in it at a pressure of 1 atmo., a hydrion concentration in the solution of about 10^{-6} would be required for a potential of $-0{\cdot}55$ volt, and such a hydrion concentration would probably occur in a solution of chromous sulphate which is saturated with chromous hydroxide. When newly deposited electrodes are brought into a very feebly acid solution of chromous sulphate they give a potential of $-0{\cdot}7$ to $-0{\cdot}8$ volt. This potential is not only given by the electrodes under the conditions mentioned, but also when, after the end potential has been reached, they are polarised kathodically or anodically in chromous sulphate solution, or kathodically in sodium hydroxide, or are treated with bromine water.

As a result of numerous such measurements, the author gives $-0{\cdot}75$ volt as the equilibrium, or *active*, potential of chromium. For this active potential to be obtained sufficient hydrogen must be present in the metal to promote catalytically the establishment of equilibrium. If the metal loses hydrogen so that the pressure falls to one atmosphere, the end potential of $-0{\cdot}55$ volt is obtained. T. S. P.

815. *Lead Electrode.* II. **F. H. Getman.** (Am. Chem. Soc., J. 40. pp. 611–619, April, 1918.)—In continuation of previous work [Abs. 743 (1916)] the e.m.f. of the cell $\overset{-}{\mathrm{Pb}}|0{\cdot}1m$ KCl sat. with $PbCl_2\|0{\cdot}1m$ KCl, $Hg_2Cl_2|\overset{+}{\mathrm{Hg}}$ has been measured at 25°, using various lead electrodes. The values of the e.m.f. obtained with different specimens of lead cast in sticks, with electrolytically deposited lead, and with amalgams, were practically identical, the average value being 0·5893 volt. The normal electrode potential of lead was calculated to be 0·4121 volt referred to the normal calomel electrode, and 0·1293 volt against the normal hydrogen electrode. The values of the e.m.f. of cells containing electrodes which had been immersed for varying periods of time in Heller's solution [see Abs. 1331 (1917)] were found to be uniformly higher than the values obtained with cells containing electrodes which had not been subjected to this treatment. The heat of the reaction $Pb + Hg_2Cl_2 = PbCl_2 + 2Hg$ was calculated to be 21,840 cals., whence the heat of formation of lead chloride was computed to be 84,440 cals. The heat of reaction, U_0, and the max. work, A_{234°, were calculated by means of the Nernst-Lindemann equation and the computed value of the e.m.f. at 234° (abs.), namely 0·521 volt, was found to be in close agreement with that obtained experimentally by Pollitzer, viz., 0·525 volt. T. S. P.